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# Some Interesting Problems in New Brunswick Geology

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II.—*Some Interesting Problems in New Brunswick Geology.*

By R. W. ELLS, LL.D.

(Read May 25, 1905.)

The geology of the southern part of the province of New Brunswick, from the Maine boundary on the west to the Petitcodiac river on the east, presents some of the most interesting problems for investigation to be found in Canadian field-work.

The rock formations extend from the base of the Archæan upward into the Triassic. The intermediate formations are often intricately folded and faulted, while over large areas metamorphism has proceeded to such an extent that comparatively new rocks present the aspect of the old crystalline schists. In the comparative absence of organisms in many places great difficulty has been experienced in working out the structure satisfactorily.

The oldest series, usually styled pre-Cambrian, consists for the most part of crystalline rocks. In places these are intimately associated with comparatively recent formations. The lowest portion, comprising limestone, gneiss, granite and quartzite, was originally styled the Portland group, which was regarded as belonging to the Laurentian system. It is now considered as the equivalent of the Grenville and Hastings series of Ontario and Quebec. The upper portion was divided into three groups, known respectively as Coldbrook, Coastal and Kingston, and these were regarded as probably representing the Huronian of Ontario. The position of all these rocks was determined by the occurrence of fossiliferous Primordial or Cambrian sediments, usually known under the name St. John group, at various places in an overlying attitude, so that very little doubt could exist as to the horizon of most of these crystalline rocks.

Of the newer formations, after passing over the Cambrian slates, which are readily identified by their contained fossils, large areas of slates and associated rocks are found, which were regarded as in past Cambro-Silurian, Silurian or even Devonian in age, though many of these were so much altered by local intrusions or by regional metamorphism as to resemble very closely in physical character much of the pre-Cambrian. In the working out of the problems presented, therefore, very careful attention was necessary, in order to interpret correctly the stratigraphical sequence, which was often complicated not only by the presence of faults and overturns, but by an absence of fossil remains over large areas.



It is scarcely matter for surprise therefore that, as the work of unravelling this complicated structure proceeded, changes of view, both as regards the age and the relative position of several of these groups, should be made as new light was afforded either by obtaining fresh fossil evidence, or by other features brought out through more detailed investigation.

The study of these rocks has been carried on for considerably more than half a century. As early as 1838, Dr. Gesner published his first report on the geology of the province, in which several of these rock divisions were described according to the nomenclature of that early date. Up to 1872, when the publication of the series of map sheets on the geology of the province was commenced by the Geological Survey, there had been but little detailed study of the rock formations. There was practically no map of the province as a whole, outside a very general one, compiled many years before on the small scale of eight miles to the inch, so that it was practically impossible, in the absence of topographical details, to lay down geological boundaries with any attempt at accuracy.

Certain geological formations had, however, been fairly well recognized, more especially near the city of St. John, owing to the work of Hartt, Matthew and Bailey, assisted by Sir William Dawson; and among these were areas of slate and sandstone, well developed in the city of St. John itself, and traceable for some miles to the east. These contain a somewhat abundant fauna of Cambrian fossils, which were to some extent determined, as was also the fact that this group of sediments rested unconformably upon the series of crystalline rocks, which were regarded as closely resembling the Laurentian and Huronian of the west.

A well defined belt of rocks which contained an abundant flora of Devonian age was also recognized, and this formation was traced over a considerable area both to the east and west of St. John city. Large collections of plant remains, and other organisms were made by Professor Hartt, which were carefully studied by Sir William Dawson, and their horizon ascertained.

At this time, a large area of partly crystalline rocks, which extended eastward from St. John into Albert county, was considered, on quite insufficient evidence, as also belonging to the Devonian system, and in the map accompanying "*Acadian Geology, 1868*," this area was so coloured. In 1869, Dr. T. Sterry Hunt, at that time an officer of the Geological Survey of Canada, visited the province, and was greatly impressed with the resemblance of many of these so-called Devonian rocks to those of the mountain areas in the Eastern Townships of Que-

bec, which he had recently studied and had decided to be of pre-Cambrian age, thus opposing the views long held by Sir William Logan as to their geological position. The occurrence of Cambrian slates on the flanks of this ridge in New Brunswick confirmed the opinion expressed by Dr. Hunt, that these rocks were much older than had been supposed. They were in consequence removed from their position in the Devonian and placed in the pre-Cambrian series.

In determining the exact horizons of the Palæozoic formations, the work was rendered difficult from an almost entire absence of fossils in most of the rocks outside the Cambrian and Devonian. Occasionally when such were found they were too imperfect for determination, and so were of but little value. Occasionally a patch of Silurian rocks show the presence of organisms, but the larger areas are practically barren. In lithological character there is a marked dissimilarity between the supposed Silurian and Cambro-Silurian formations of this province as compared with those found in Quebec and Ontario, which are regarded as their equivalents, and where the nomenclature of the New York Survey has been closely followed. So great is this difference in the case of the New Brunswick rocks that in the absence of fossils the determination of actual horizons is often practically impossible.

The oldest rock group in the southern part of the province has already been referred to as probably of Laurentian age, under its old designation, the "Portland group." This group, with another called the Coldbrook, comprised what in 1865 was known as the Azoic. The Portland included a considerable thickness of crystalline rocks with some schists, and was easily traced for some miles to the north-east of the city. But when in the course of this investigation other outcrops of apparently similar rocks were found to the west in Charlotte county, where there is no overlying Cambrian formation to fix the position definitely, the attempted correlation of such groups of crystalline rocks, with the so-called Laurentian of St. John, could not be conclusively effected. Still, largely on lithological grounds, such a correlation was made, more particularly in regard to certain areas of crystalline limestone and schist which occur on Frye's island and Letang, and this classification remained in force for many years.

During a recent detailed investigation of these crystalline rocks in Charlotte county, it was found that the supposed Laurentian limestones are merely highly altered Silurian sediments, with which are associated a considerable thickness of squeezed eruptives, to which a schistose structure has been imparted, so that they now closely resemble the pre-Cambrian schists near St. John.



The areas of these Charlotte county crystalline rocks are quite small. On close examination the crystalline limestone is seen to pass gradually into the ordinary blue variety which is associated with shales and sandstone, both being in places filled with Silurian fossils. In the crystalline limestone itself there are traces of organisms, mostly corals, which have become silicified and flattened out by pressure of the surrounding rocks, but which still show the marks of their organic origin. In the absence of these fossils, from a cursory examination or from hand specimens only, these rocks might readily be taken for some part of the pre-Cambrian.

A striking similarity of occurrence is seen in the province of Quebec in a group of Silurian and Devonian slates and limestones on Memphremagog lake. Here also the blue limestone is changed to a true marble, the slates to talcose and mica schist, and the fossils, though silicified and squeezed flat, yet retain their organic markings. A like difficulty of classification was for a time experienced in these Quebec rocks as in New Brunswick, till the contained fossils were discovered, and the cause of the alteration ascertained.

The Huronian division of the pre-Cambrian in the southern part of the province included the Coldbrook, Coastal and Kingston; and while the position of the first two has always been regarded as secure, a certain amount of doubt has for many years existed in regard to portions of the last named. Thus the Coldbrook and Coastal are overlaid by the Cambrian at a number of points, as is also the case with some portions of the Kingston, as seen along the St. John river; but at other points the latter appears to be closely associated with sediments, which contain Silurian fossils, in which there is an apparent dip beneath the rocks of the Kingston peninsula. This peculiarity of structure at one time led to the supposition on the part of one of the local geologists that the group as a whole should be referred to the Silurian rather than to the Huronian, and they were so described in one of the Reports of the Geological Survey for the year 1877-78. A re-examination of the area, however, showed that the Silurian sediments rested unconformably on the flanks of the crystalline rocks, so that this view of the structure was abandoned.

The rocks of the Kingston group, as found in the Kingston peninsula, from which place the name for the division was derived, were supposed to extend south-west from the St. John river to the east coast of Passamaquoddy bay in Charlotte county. No trace of fossiliferous Cambrian is, however, found in this direction, these rocks being practically confined to the areas east of the St. John river; but certain reddish conglomerates with sandstone occur along the railway west of

the river, and these were regarded as representing the basal beds of the Cambrian in this direction.

This westward extension of the supposed Kingston passed near the village of St. George, and thence, south-westward, extended through Letite peninsula, continuing on and forming most of the group known as the Western isles. The rocks in this extension west of St. George include schist, felsite, diabase, granite, squeezed eruptives, slate and conglomerate. As a whole, they may be classed as a highly metamorphic series. They are thus in character not unlike much of the typical Kingston of the St. John river.

For some years it was supposed that the series as a whole belonged to the Upper Silurian system, owing to the presence of fossils of that age in some of the less altered portions. Ultimately, at the date of publication of the map of Charlotte county, it was decided, chiefly on lithological grounds, to place the whole group provisionally in the pre-Cambrian, and to regard the fossiliferous Silurian as small infolded areas. This decision applied to the rocks of Letite peninsula, as well as to those of Deer and Campobello islands and those found along the east side of Grand Manan.

The rocks in this group are largely volcanic. They are also of comparatively recent date instead of being pre-Cambrian. They cut and alter limestone and shale, which are filled with Upper Silurian and Devonian fossils. Owing to metamorphism certain portions of these sediments are changed to schists of various kinds; but even in parts of these a careful search will sometimes reveal traces of organisms. As a whole, therefore, this part of the Kingston group so-called, as developed in Letite and in the Western isles, must be removed from the pre-Cambrian as coloured on the geological map, and classed as Upper Silurian in part and in part as volcanic.

An interesting locality in the Letite area as showing the degree of alteration to which these sediments and volcanics have been subjected, is near the light-house on Letite Head. Here the original Silurian slates have been changed into hard felspathic schist, while the associated masses of diabase have assumed the aspect of chloritic schist. Yet in certain bands of slates associated with the former the traces of fossils can be recognized, and are sometimes abundant, though frequently much distorted. It was only by carefully tracing out the actual relations of the fossil-bearing bands from their highly crystalline condition that their true position as a part of the Upper Silurian was definitely ascertained.

There is, however, a belt of pre-Cambrian schists and associated rocks in the south-eastern portion of Charlotte county, which extends



south-west from the lower part of the St. John river. This belt reaches the shore of the Bay of Fundy, a short distance east of Beaver Harbour, and thence occupies most of the distance to Barnaby Head at the west entrance to Lepreau harbour. The schists are largely hornblendic and gneissic, and these make up a large portion of the area, but there are also large masses of granite and granite-gneiss. These rocks underlie the Silurian, and as a body are quite distinct from those portions of the so-called Kingston group seen at Letite and just described. They are probably the extension of the more crystalline portion of the Kingston group, which lies to the north of Kennebecasis bay.

In the study of these crystalline rocks north of the Bay of Fundy, it was found that the crystalline character was sometimes caused by local intrusions, though principally due to regional metamorphism. Generally speaking, it appears that the whole area extending from the Maine coast through the chain of the Western isles, as well as the adjacent shores of New Brunswick, was a great centre of volcanic activity at a comparatively recent date. Most of these volcanic rocks appeared probably at or near the close of the Upper Silurian or in the early Devonian time, since in the latest Devonian, as represented by the red rocks of the Perry group, the only evidence of such intrusion in New Brunswick is the presence of a few dykes of diabase, which cut directly across these sediments and have altered them to some extent. On the island of Grand Manan, however, there is evidence of a later eruptive period, which has produced the great mass of trappean rock which now forms the western wall of the island, and from which a spur cuts across the Devonian or Silurian volcanics which form the mass of Fish Head at the north-east end. These traps are very like those of the North Mountain in Nova Scotia, and are probably referable to the Trias.

On the shores of Oak bay, which is an arm of the St. Croix estuary to the north, there are numerous outcrops of hard and altered slates, often highly felspathic, and breaking with a sharp conchoidal fracture. Though highly altered, certain bands contain Upper Silurian fossils sufficiently well preserved to be determinable. The whole series in this area is highly metamorphic, very often from local intrusions, and the slates are intersected by igneous rocks, which comprise gabbro, granite, felsite and diabase. The slates are altered along the contacts, and are sometimes sharply cut off by the intrusive rocks. Occasional heavy bands of conglomerate are found on the shore, the pebbles in which appear to be of volcanic material. In the direction of the St. Croix river, as at St. Stephen and Calais, these slates are invaded by heavy masses of gabbro and gabbro-granite.



To the north of this place there is a broad belt of argillites, which extends across the country from the vicinity of Milltown on the St. Croix into Queen's county. It is interrupted in places by the large granite mass of the eastern part of Charlotte county. Portions of this slate series, as developed near the head of Oak bay, were at one time regarded as possibly representing the Cambrian slates of St. John, but of this no evidence could be found. As a whole the slates and associated rocks of this series, to which the name "Dark argillite" was given, was regarded in 1877 as possibly of Upper Silurian age, but in default of definite evidence, in the final colouring it was decided to place them provisionally in the Cambro-Silurian system, until more definite information could be obtained. Certain portions, however, in which Silurian fossils were detected were separated.

In this Upper Silurian portion, however, at that time were included considerable areas of felspathic and other igneous rocks, the relations of which to the fossiliferous Silurian were supposed to be such as to warrant their inclusion in that system. These felsites are as a mass, clearly intrusive. They cut across Silurian and Devonian sediments at many points, and though they sometimes present an apparently bedded aspect, this feature is due rather to flow structure than to true bedding. In places these rocks are highly crystalline and porphyritic.

They form a somewhat prominent series of hills along the north side of Passamaquoddy bay, among which are the Chamcook mountains, Mount Blair, and several others to the north and west of St. George. A large area of these rocks extends eastward from the line of St. Andrews railway at Chamcook lake, past the head of Bocabec bay, till it connects with the great granite mass of the interior. The masses of felsite which occur at many points are probably of the same age as these granites, since they appear to pass into one another. Dyke-like masses cut the formations below the Perry group and the basal beds are largely made up of masses and pebbles of all sizes from the felsite hills, the conglomerate often flanking their bases.

From the fact that these volcanics, as a group, are evidently more recent in age than the Upper Silurian, there is no valid reason why they should remain as an integral part of that system. In the revision of the geology of this district, therefore, they have been separated from the Silurian proper, and coloured as a portion of the volcanics series.

About St. Stephen and for several miles along the St. Croix on the New Brunswick side, and at Calais in Maine across the river, there are large masses of a greenish-grey rock, for the most part at least a gabbro, which in 1870 was regarded as a gneiss, and referred to the Laurentian. These rocks are surrounded by a series of altered black



and grey slates, which have, along the contacts, been changed to stauro-lite and mica slates and schists, the alteration being in this case due to local causes. Further from the contact, the slates, while tilted at high angles, present the aspect of dark-grey, sandy and argillaceous sediments.

These gabbro rocks outcrop at a number of points through the slate belt, and in every observed case the same phase of alteration is visible. Instead of these rocks being Laurentian, they are therefore clearly of later date than the slates which they penetrate, and as these are of Silurian age, the intrusives must be in part at least post-Silurian. Along the outer zone of these gabbros there are occasional pockety masses of nickeliferous pyrrhotite, which have been sometimes compared with the nickel deposits of Sudbury, Ont. In point of time they are, however, widely different, since no Huronian rocks are visible in this part of the province.

Closely related to the Silurian rocks, although much doubt existed for many years as to their true horizon, is the group found on the east side of Passamaquoddy bay, near the outlet of the Magaguadavic estuary, and known as the "Mascarene series." The rocks are shales and slates of various colours, often reddish or purple tinted, which are cut by masses of green diabase and felsite, which have altered the strata along the contact. In the lower part there are other masses of felsite, which on lithological grounds were at one time regarded as possibly Huronian.

The examination of these felsites show them, as elsewhere, to be intrusive in the shales of this series, and therefore newer. In the shales themselves fossils are found at a number of places. They are mostly shells, but certain of the shell-bearing bands also hold well defined plant stems, so that as a whole the rocks have the aspect of lower Devonian rather than of Upper Silurian sediments. As a series, they rest upon the Upper Silurian fossil-bearing slates of Letite. They are overlaid unconformably at several points by the red upper Devonian beds of the Perry group, and between these two divisions there are in places heavy flows of red felsite, which on first sight resemble inter-stratified beds. The felsite outflow was, however, older than the Perry, since large pebbles from it are found in the basal conglomerates of the latter. Stratigraphically the Mascarene series may be placed between the Letite Silurian and the Perry sandstone, and may be regarded as lower and middle Devonian, or not far from the characteristic Devonian of St. John and vicinity.

The rocks of the Perry group have furnished much material for discussion. As first examined in Maine by Dr. Jackson, and subsequently by Sir William Dawson and Professor Hitchcock, they were pronounced to be a part of the Devonian system, this claim being well estab-



lished from the examination of large collections of plant remains made at Perry, Maine, and on the peninsula of St. Andrews. The beds consist of a coarse conglomerate at the base, which rests upon the flanks of the felsite mountains at a number of points. It is largely made up of their debris, and passes upward into a great series of shales, sandstone and other conglomerates, the former containing plant impressions. Dykes of green diabase cut the strata about two miles north of St. Andrews point, and extend across the peninsula, reappearing at Ministers island. This diabase is clearly intrusive, altering the shales in contact. The beds as a whole are but little disturbed, the dips being rarely over 25 degrees, and this dip is fairly constant south from Chamcook mountain to the end of St. Andrews point, thus giving a thickness of not much under 7,000 feet for these rocks.

In the report for 1870-71, the Perry group was assigned, by Bailey and Matthew, chiefly on lithological grounds, to the lower Carboniferous, from the resemblance of these rocks to certain conglomerates and sandstones which are exposed on the shores of Kennebecasis bay, an arm of the St. John river, a few miles north of St. John city. In view of the clearly Devonian aspect of the fossils of the group, it would appear that this change in nomenclature was entirely unwarranted. The formation, as a whole, is clearly distinct from the recognized lower Carboniferous of the central basin, and has a much greater thickness than can be assigned to the rocks of that formation in any part of the province. The weight of evidence is therefore greatly in favour of their Devonian age, and they have been referred back to their original position. It is, however, by no means clear that the Kennebecasis conglomerate is lower Carboniferous. Farther east, on the shore of Albert county, are large masses of hard and coarse conglomerate, which, while regarded as lower Carboniferous at the date of their examination in 1877, are now generally conceded to be Devonian, since they are unconformably beneath the lower Carboniferous limestone division.

These Perry rocks are the newest in the geological scale in this part of Charlotte county, but on the northern boundary the lower Carboniferous portion of the Central basin is exposed for a short distance.

Since writing this paper the Devonian age of the Perry group has been clearly confirmed on the evidence of fossil plants, which have been studied by Messrs. White and Smith, of the United States Geological Survey, the results of their study being published in the official bulletin of that Department, 1905.

The rocks of Grand Manan island, which is the most southern portion of the province of New Brunswick, differ from those of the main land in some respects. They are divisible into two parts, viz., the



heavy mass of trap or diabase along the west side, already referred to, which in fact occupies the greater part of the island; and a series of slates and conglomerate, which is found on the east side and on several islands off this coast.

The rocks of this slate series are similar to those seen on the main land near Letite. They are cut by large masses of green eruptives of an older date than the trap ridge, and they are altered along the contact. On the north end of the island one of these contacts is well seen at Cameron cove on the south side of Fish head, where the slate adjacent to the intrusive mass has become graphitized, and certain masses of limestone in the vicinity are much changed in character.

The eastern limit of the trap ridge at the north end of this island is on the west side of Whale cove, the actual contact with the slates not being seen at this place. At Red head on the east side of the island, a short distance north of Seal cove, there is a direct contact between the trap rocks and the Silurian slates, the latter being altered for some distance from the junction. The slate rocks are seen on several of the islands off the east coast, and are altered to schists, resembling strongly the rocks on Deer island and on Letite head. Masses of felsite and diabase are common in this direction. All these slaty rocks may now be classed as Upper Silurian instead of pre-Cambrian, and as indicated on the published map. Traces of fossils can be seen in several of the ledges along the shore, but the specimens are too indistinct for determination. The presence of the Silurian on this island is probably due to an anticline between this place and Deer and Campobello islands to the west.

The rocks of the Wolves group of islands, which lie about six miles off shore from Beaver harbour, are for the most part granitic. There are no means of ascertaining their age by direct contact with other formations, but from the fact that they lie in the direct strike of the pre-Cambrian rocks east of Beaver harbour, it is probable that all these islands may represent an outlying portion of this series.

The Devonian rocks of St. John and vicinity have furnished material for discussion for many years. The shales and sandstones of the Fern ledges, near Carleton on the west side of the harbour, were found by Hartt as early as 1860-61 to contain an abundant fossil flora, which was carefully studied by the late Sir William Dawson, for many years the leading authority on fossil plants in Canada. The horizon of these rocks was definitely fixed both by the evidence of the contained plants and from their stratigraphical sequence as beneath the Carboniferous formations.



Quite recently an attempt has been made to revise this classification of the Devonian rocks near St. John city. It is assumed by certain palæobotanists that the determination of the fossil plants by Sir William was incorrect, and that the later determination of these, based on a correlation with plant remains obtained from strata of supposed Carboniferous horizons in the United States, must place these rocks in New Brunswick about the horizon of the middle or even upper Carboniferous. This assumption is made purely on plant evidence and without regard to the stratigraphical sequence of the sediments in question. The history of this controversy is interesting.

The Devonian beds of St. John were in 1884 correlated with certain sediments which occur in Nova Scotia, and which there form an extensive belt, continuing across the northern portion of the province from the head of the Bay of Fundy, past the town of Truro, and as far east as the Strait of Canso. In this province the succession and actual horizon of these rocks had been carefully worked out by Mr. H. Fletcher as the result of several years close study over a large area. They were found to agree precisely with the Devonian shales and sandstones near St. John, not only in their lithological characters and their contained fossils, but in their stratigraphical relations to the lower Carboniferous as well, in being unconformably beneath the limestones of that formation. In Nova Scotia, east of Truro, the rocks of the series are known locally as Riversdale and Union, and have been correctly mapped as a part of the Devonian series.

A few years prior to this correlation, Sir William Dawson had obtained a few plant remains, which were admittedly imperfect, from the rocks of this series near Riversdale. Upon examination, he decided that these fossil plants belonged to the horizon of the Millstone grit. The strata from which these plants were obtained have, however, been shown to be an integral part of the great series which has been proved, both in New Brunswick and Nova Scotia, to unconformably underlie the lowest known lower Carboniferous rocks, including the lower Carboniferous limestone. The position of this formation is definitely fixed in the geological scale on the evidence of marine fossils, as also by its being stratigraphically beneath the Millstone-grit and productive coal-measures; so that to accept the recent determinations of the palæobotanists would necessarily remove the lower Carboniferous, with the other members of the Carboniferous system, altogether above their true position in the geological scale. Areas of these lower Carboniferous limestones are found at a number of points capping or overlying the so-called Devonian shales and sandstones of the Riversdale series.

It would therefore appear that in our present somewhat imperfect knowledge as to the exact range of fossil plants, the precise determination of horizons must still be regarded, to some extent at least, as unsatisfactory.

An interesting series of bituminous shales and sandstones, with thin bands of dolomite, occurs in Albert county, where it is known under the name "Albert shale." Fossils, mostly confined to remains of small fishes, are occasionally found in widely separated strata, and sometimes the remains of plants are obtained. The formation, as a whole, cannot be regarded as richly fossiliferous, though the rocks themselves are highly bituminous throughout. This formation rests upon the flank of the pre-Cambrian hills of Albert county.

In the special examination of this formation in 1876, it was clearly shown that, stratigraphically, these shales underlie unconformably, the lowest known lower Carboniferous sediments, agreeing in this respect closely with the Devonian sediments near St. John city. From the study of the few fossils which were obtained many years ago, chiefly fishes, it was decided by Sir William Dawson, that their horizon was lower Carboniferous; and in the colouration of the map of the district they were accordingly so indicated, despite the stratigraphical evidence to the contrary.

Subsequently the stratigraphical sequence of a series of similar rocks, found along the Avon river in Nova Scotia, where they were long known as the "Horton series," was established by Mr. Fletcher. They were also found, like the Albert shales, to underlie unconformably the lower Carboniferous of that district. From the evidence now at hand, therefore, it may be asserted that the Albert shales of New Brunswick are a part of the Devonian series of formations.

The name "Dark argillite" series, which has already been briefly alluded to in the remarks on Charlotte county, was given to the belt of slates and sandstone with occasional schists and quartzite, which traverse that county from the Maine boundary eastward. Their removal from the Cambro-Silurian, where they were provisionally placed in 1877-78, to the Upper Silurian system, as the result of recent investigation, will involve a further study of several large areas of practically similar sediments lying to the west of the St. John river between Fredericton and Woodstock, as also of the somewhat kindred rocks to the north of the St. John in the direction of the Miramichi.

In support of this contemplated change, it may be said that several years ago upper Silurian fossils were found in the supposed Cambro-Silurian rocks by Mr. W. J. Wilson, at a point a few miles north of Canterbury on the railway line, so that doubt has existed for some time



as to the correctness of the former determination of this area. At a point a few miles west of Fredericton, also, Dr. Bailey claims to have quite recently found graptolites of upper Silurian age. The tendency of these two new discoveries will be to place a portion at least of these two areas in the Silurian system. On the other hand, it is claimed by the local geologists that graptolites of Cambrian age have been found in some parts of the more northerly or Canterbury area. The evidence as to the actual age of this supposed Cambrian fossil is at present far from conclusive, since it has not yet been carefully studied. Further detailed work is therefore required in this area to arrive at a satisfactory solution of the problem as to the exact horizon of these slates and associated strata. As in Charlotte county fossils capable of determination are rarely met with.

In the northern and central portions of the province our knowledge of the geology is much less complete than in most of the southern half. Much of the interior is accessible only with great difficulty, and chiefly by canoes on the larger streams, or along certain trails or lumber roads, since large areas are as yet entirely unopened for settlement. From investigations made in 1879-80, however, a fairly accurate map was constructed and published, on which the principal geological features, in so far as could then be ascertained, were laid down.

The principal lines of traverse across the northern area between the St. John and the Bay des Chaleurs is along the Tobique and Nipisiguit rivers. These streams head in close proximity to each other about midway across this part of the province. Along the former the geological formations are comparatively easy to determine, consisting of a large area of upper Silurian slates and limestone, extending thence north to the Restigouche river, which marks the boundary of the province in this direction. These rocks are overlaid by lower Carboniferous conglomerate and sandstone, with which are associated beds of gypsum. To the south of this are ridges of volcanic rocks, which underlie the Carboniferous basin. They consist for the most part of felspathic rocks, with a considerable development of green diabase, forming what is locally known as the "Blue mountains."

These volcanics extend eastward to the right hand branch of the Tobique, which joins the main stream at what is called Nictor forks. On this branch they cut across the Silurian limestone and slate, and alter these along the contact. Farther east in the direction of Nictor lake, which is at the head of the left branch of the Tobique, a number of hills are seen, some of which probably represent the highest land in the province. These hills are also in part felsitic. As a whole, in

so far as these Tobique rocks have been examined, they closely resemble in character the volcanics of western Charlotte county (felsite and diabase), which have already been described as probably late Silurian or Devonian in point of time. This group of volcanics may therefore be correlated with the Charlotte county eruptives.

At Nictor lake, volcanic rocks have a large development, rising almost from the water's edge to elevations of 1,500 to 2,600 feet above sea level. The largest of them, known as Sagamook or Bald mountain, is flanked on the north or lake side by Silurian slates containing scattered pebbles of felsite in the lowest portion. They have a schistose structure in places, and resemble very closely in this respect certain parts of the Silurian of Charlotte county. The alteration does not resemble that resulting from the action of igneous rocks which have intruded through the slates, since there are no crystals of staurolite or allied minerals, such as are found elsewhere in connection with the granite masses. It appears rather to be caused by regional movements subsequent to the deposition of the Silurian sediments.

This range of volcanic hills has not been examined in detail to the westward, owing to the great difficulty found in traversing this district. To the east, however, they have been traced for some miles, and they occur on both sides of the Nipisiguit. They extend eastward to within about five miles of the Portage brook, which is a small tributary of the Nipisiguit from the north, along which a portage route extends across to the head waters of the Upsalquitch and thence to the Restigouche. Throughout this chain of volcanic hills the rocks are largely felsitic in character, but occasionally they pass into granites. The felsites are sometimes hard and porphyritic, and occasionally show a well-defined flow structure, which on first sight presents the aspect of true bedding.

East of this chain of hills, the rocks, as seen in the ridges on either side of Portage brook, are for the most part crystalline schists, in places gneissic, resembling the pre-Cambrian schists of southern New Brunswick. They are as a series, quite distinct both from the altered Upper Silurian and from the volcanics. They extend north from the Nipisiguit along Portage brook and the upper part of the Upsalquitch for some ten miles, where they are overlaid by conglomerates with pebbles of the underlying rocks, felsites and hard slates, the series containing Upper Silurian fossils, and passing up into the characteristic Silurian slates and limestone of the Upsalquitch-Restigouche basin. The southern limit of the Silurian rocks is therefore definitely fixed in this direction.

A prominent hill, which is known locally as the Peak of Teneriffe, rises to the south of the lower of the three lakes which form the head



waters of the Nipisiguit river, its elevation above the lake near the base being about 1,260 feet. On this mountain, at a height of about 400 feet there is an exposure of grey sandstone, shale and conglomerate lying nearly flat on the southern face of the mountain. The shale holds plant stems, and the whole closely resembles Devonian rocks seen along the Upsalquitch, and at points along the lower Restigouche at the head of the Bay des Chaleurs. These sediments are practically unaltered. They have apparently not been subjected either to local metamorphism by igneous rocks or affected by crustal movements. They have no connection with the rocks of the great Silurian basin to the north and west, but are apparently the remains of a somewhat, at one time, extensive area of Devonian sediments, the greater portion of which has long been removed by denudation. Another small Devonian outlier is found to the westward on the Campbell branch of the Tobique, but the characters of the rock and of the contained fossils is somewhat different to those seen in the outlier on Mount Teneriffe. From the examination of the whole range of these felsite and granite hills, it would appear that they owe their present position to intrusion, as is the case with the somewhat similar masses in the southern part of the province, and not to overflows over the great areas of Upper Silurian, which lie to the north.

In regard to the age of these northern felsite hills, it may be said that portions of them resemble very closely the old felsite masses of the pre-Cambrian areas east of St. John, but in the absence of typical Cambrian sediments in this district, their pre-Cambrian age cannot be definitely asserted, though on their first examination they were so regarded. In so far as the more recent examinations have been made no definite evidence has been obtained to warrant, at present, any great change of opinion on this point. Certain portions of these hills are undoubtedly older than Silurian, while the post-Silurian age of the diabase and felsite rocks along the lower Tobique, and at a number of points between this area and the Bay des Chaleurs, has long been known, and has been pointed out in earlier reports. It is therefore very probable that in this volcanic area igneous rocks of widely different ages occur as in the southern part of the province. On both sides of the great central Carboniferous basin there appears to have been several periods of volcanic activity, which developed chiefly along two lines, one of them, the more southerly, extending across the country north of the Bay of Fundy from the Maine boundary nearly to Northumberland strait, the other from the Maine boundary in York county north-east across the province to the Bay des Chaleurs, and reappearing on the south side of Gaspé peninsula.









